POSITION 139: COLLING A, 5.1, S.17

1. Input parameters

verifications acc. to DIN EN 1995, Germany

1.1. floor diaphragm

panel width b = 7.500 m with ⊥ h_{eff} = 5.625 m, panel height h = 8.750 m with ⊥ h_{eff} = 3.750m
b < 2 h ⇒ acc. to NCI Zu 9.2.3.2 (NA.5) load application by continuous distributing beams
(or setting of h_{eff} = b/2)

1.2. ribs

solid coniferous timber, C24 (S10), NKL 1, ρ_k = 350 kg/m³, a_r = 0.625 m
edge **100/220**, inner **100/220 mm**, oriented in x-direction
edge beams **100/220 mm**, inner beams **100/220 mm**

1.3. sheathing top

HAAS 3S (user defined) with ρ_k = 0 kg/m³, NKL 1, b/h/t = 1250/2500/28.00 mm in y-direction

1.4. user defined parameters plywood HAAS 3S

stiffness parameters [N/mm²]

plate action effect	parallel	vertical
mod-ela E_{mean}	3500	4500
shear mod. G_{mean}	650	1200

diaphragm act. eff.	parallel	vertical
mod-ela E_{mean}	2500	2500
shear mod. G_{mean}	650	1200

strength parameters [N/mm²]

plate action effect	parallel	vertical
bending $f_{m,k}$	5.25	5.25
compr.$f_{c,k}$	13.90	13.90
shear $f_{v,k}$	3.50	3.50

diaphragm act. eff.	parallel	vertical
bending $f_{m,k}$	5.25	5.25
tensf$_{c,k}$	2.00	2.00
compr.$f_{c,k}$	13.90	13.90
shear $f_{v,k}$	3.50	3.50

modification coefficients k_{mod}

service class	1	2	3
permanent	0.46	0.46	0.20
long-term	0.54	0.54	0.40
med.-term	0.62	0.62	0.60
sh.-term	0.69	0.69	0.80
instantan.	0.77	0.77	1.10

deformation parameters k_{def}

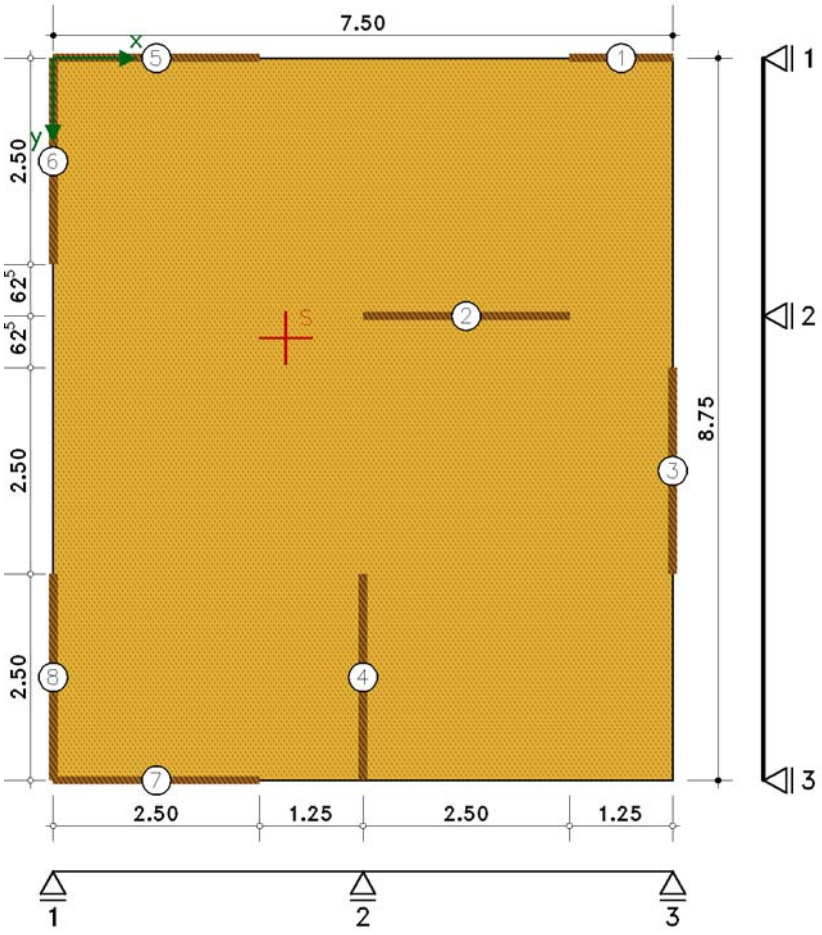
service class	1	2	3
k_{def}	3.00	3.00	3.00

embedment stress calculated by user defined formula: $f_{h,k} = 127.00\ d^{(-0.70)}\ t^{(0.00)}\ \rho^{(0.00)}$

1.5. Fasteners top

nail, 3.4 x 60.0 mm, d_k = 7.7 mm, not predrilled
detailed verification acc. to DIN EN 1995, 8.2.2, distance a_v = 68 mm, 1-row

elevation scale 1:0.917



1.6. sheet edges

no free sheet edges

1.7. walls

Nr	x_a	x_e	y_a	y_e	l
-	m	m	m	m	m
1	6.250	7.500	0.000	0.000	1.250
2	3.750	6.250	3.125	3.125	2.500
3	7.500	7.500	3.750	6.250	2.500
4	3.750	3.750	6.250	8.750	2.500
5	0.000	2.500	0.000	0.000	2.500
6	0.000	0.000	0.000	2.500	2.500
7	0.000	2.500	8.750	8.750	2.500
8	0.000	0.000	8.750	6.250	2.500

1.8. spans in x-direction

axis	l	walls
	m	
1	3.750	6+8
2	3.750	4
3	0.000	3

1.9. spans in y-direction

axis	l	walls
	m	
1	3.125	5+1
2	5.625	2
3	0.000	7

2. results

2.1. wall forces

x_s = 2.813 m, y_s = 3.393 m, I_p = 211.77 m^5, $e_{x,s}$ = 0.000 m, $e_{y,s}$ = 0.000 m (wall eccentricity)

2.1.1. Load combination 1: wind

wind in x-direction, application of load from one side

w_x = 4.64 kN/m, $e_{y,w}$ = 0.000 m ⇒ $w_{l,x}$ = 4.64 kN/m, $w_{r,x}$ = 4.64 kN/m, ΔMx = -0.00 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	1.250	0.000	-3.393	5.800	0.000	5.800
2	2.500	3.125	-0.268	11.600	0.000	11.600
5	2.500	0.000	-3.393	11.600	0.000	11.600
7	2.500	8.750	5.357	11.600	-0.000	11.600

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	17.400	0.000	---	---	---	---
-	1x	---	---	17.400	2.900	---	---
2x	-	11.600	31.719	---	---	---	---
-	2x	---	---	14.500	-11.600	54.375	3.125
3x	-	11.600	39.875	---	---	---	---

2.1.2. Load combination 2:

wind in x-direction, application of load from one side

w_x = 4.64 kN/m, $e_{y,w}$ = 0.875 m ⇒ $w_{l,x}$ = 1.86 kN/m, $w_{r,x}$ = 7.42 kN/m, ΔMx = -35.52 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	1.250	0.000	-3.393	5.800	0.711	6.511
2	2.500	3.125	-0.268	11.600	0.112	11.712
5	2.500	0.000	-3.393	11.600	1.423	13.023
7	2.500	8.750	5.357	11.600	-2.247	9.353

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	19.534	0.000	---	---	---	---
-	1x	---	---	19.534	10.627	---	---
2x	-	11.712	48.746	---	---	---	---
-	2x	---	---	22.339	-9.353	100.831	4.289
3x	-	9.353	94.707	---	---	---	---

2.1.3. Load combination 3:

wind in x-direction, application of load from one side

w_x = 3.46 kN/m, $e_{y,w}$ = 0.656 m ⇒ $w_{l,x}$ = 1.90 kN/m, $w_{r,x}$ = 5.02 kN/m, ΔMx = -19.86 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	1.250	0.000	-3.393	4.325	0.398	4.723
2	2.500	3.125	-0.268	8.650	0.063	8.713
5	2.500	0.000	-3.393	8.650	0.795	9.445
7	2.500	8.750	5.357	8.650	-1.256	7.394

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	14.168	0.000	---	---	---	---
-	1x	---	---	14.168	6.482	---	---
2x	-	8.713	33.171	---	---	---	---
-	2x	---	---	15.195	-7.394	66.044	4.065
3x	-	7.394	60.388	---	---	---	---

2.1.4. Load combination 4:

wind in y-direction, application of load from one side

w_y = 4.07 kN/m, $e_{x,w}$ = 0.000 m ⇒ $w_{l,y}$ = 4.07 kN/m, $w_{r,y}$ = 4.07 kN/m, ΔMy = 0.00 kNm

Nr	l_y m	x_i m	$x_i - x_s$ m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	7.500	-4.688	7.631	-0.000	7.631
4	2.500	3.750	-0.938	7.631	-0.000	7.631
6	2.500	0.000	2.813	7.631	0.000	7.631
8	2.500	0.000	2.813	7.631	0.000	7.631

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	15.262	0.000	---	---	---	---
-	1y	---	---	15.262	0.000	28.617	3.750
2y	-	7.631	28.617	---	---	---	---
-	2y	---	---	7.631	-7.631	35.771	1.875
3y	-	7.631	28.617	---	---	---	---

2.1.5. Load combination 5:

wind in y-direction, application of load from one side

w_y = 4.07 kN/m, $e_{x,w}$ = 0.750 m ⇒ $w_{l,y}$ = 1.63 kN/m, $w_{r,y}$ = 6.51 kN/m, ΔMy = 22.89 kNm

Nr	l_y m	x_i m	$x_i - x_s$ m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	7.500	-4.688	7.631	-1.267	6.364
4	2.500	3.750	-0.938	7.631	-0.253	7.378
6	2.500	0.000	2.813	7.631	0.760	8.391
8	2.500	0.000	2.813	7.631	0.760	8.391

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	16.783	0.000	---	---	---	---
-	1y	---	---	16.783	6.099	---	---
2y	-	7.378	45.765	---	---	---	---
-	2y	---	---	13.477	-6.364	65.182	2.720
3y	-	6.364	61.962	---	---	---	---

2.1.6. Load combination 6:

wind in y-direction, application of load from one side

w_y = 2.91 kN/m, $e_{x,w}$ = 0.563 m ⇒ $w_{l,y}$ = 1.60 kN/m, $w_{r,y}$ = 4.22 kN/m, ΔMy = 12.29 kNm

Nr	l_y m	x_i m	$x_i - x_s$ m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	7.500	-4.688	5.456	-0.680	4.776
4	2.500	3.750	-0.938	5.456	-0.136	5.320
6	2.500	0.000	2.813	5.456	0.408	5.864
8	2.500	0.000	2.813	5.456	0.408	5.864

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	11.728	0.000	---	---	---	---
-	1y	---	---	11.728	3.273	---	---
2y	-	5.320	29.664	---	---	---	---
-	2y	---	---	8.594	-4.776	41.151	2.560
3y	-	4.776	38.358	---	---	---	---

2.2. verification of flanges

LK	$M_{max,d}$ kNm	h_{eff} m	$F_{c,d}$ kN	$\sigma_{c,d}$ N/mm²	k_c -	k_{mod} -	u -
1	54.375	3.750	14.500	0.659	1.000	0.900	0.045
2	100.831	3.750	26.888	1.222	1.000	0.900	0.084
3	66.044	3.750	17.612	0.801	1.000	0.900	0.055
4	35.771	1.875	19.078	0.867	1.000	0.900	0.060
5	65.182	1.875	34.764	1.580	1.000	0.900	0.109
6	41.151	1.875	21.947	0.998	1.000	0.900	0.069

2.3. Verification of diaphragm loading

sheathing

γ = 1.00, f_{vk} = 3.5 N/mm², f_{ck} = 13.9 N/mm², k_{v1} = 0.66, k_{v2} = 0.33

2.3.1. Load combination 1: wind

with h_{eff} = 3.750 m, $_{max}V_d$ = 17.400 kN ⇒ s_{v0d} = 4.64 N/mm

sheathing 1

k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²

f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive

f_{v0d} = 14.77 N/mm (plate shear strength)

f_{v0d} = 23.16 N/mm (shear force buckling)

⇒ utilization: U_0 = 0.77 ⇒ **U = 0.77 verification successful**

2.3.2. Load combination 2:

with h_{eff} = 3.750 m, $_{max}V_d$ = 22.339 kN ⇒ s_{v0d} = 5.96 N/mm
sheathing 1
k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²
f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive
f_{v0d} = 14.77 N/mm (plate shear strength)
f_{v0d} = 23.16 N/mm (shear force buckling)
⇒ utilization: U_0 = 0.99 ⇒ **U = 0.99 verification successful**

2.3.3. Load combination 3:

with h_{eff} = 3.750 m, $_{max}V_d$ = 15.195 kN ⇒ s_{v0d} = 4.05 N/mm
sheathing 1
k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²
f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive
f_{v0d} = 14.77 N/mm (plate shear strength)
f_{v0d} = 23.16 N/mm (shear force buckling)
⇒ utilization: U_0 = 0.67 ⇒ **U = 0.67 verification successful**

2.3.4. Load combination 4:

with h_{eff} = 5.625 m, $_{max}V_d$ = 15.263 kN ⇒ s_{v0d} = 2.71 N/mm, s_{v90d} = 4.07 N/mm (shear flow)
sheathing 1
k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²
f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive
f_{v0d} = 14.77 N/mm (plate shear strength)
f_{v0d} = 23.16 N/mm (shear force buckling)
f_{v90d} = 9.12 N/mm (fastener) ⇒ decisive
f_{v90d} = 88.88 N/mm (plate shear strength)
f_{v90d} = 79.63 N/mm (shear force buckling)
⇒ utilization: U_0 = 0.45, U_{90} = 0.45 ⇒ **U = 0.45 verification successful**

2.3.5. Load combination 5:

with h_{eff} = 5.625 m, $_{max}V_d$ = 16.783 kN ⇒ s_{v0d} = 2.98 N/mm, s_{v90d} = 4.07 N/mm (shear flow)
sheathing 1
k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²
f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive
f_{v0d} = 14.77 N/mm (plate shear strength)
f_{v0d} = 23.16 N/mm (shear force buckling)
f_{v90d} = 9.12 N/mm (fastener) ⇒ decisive
f_{v90d} = 88.88 N/mm (plate shear strength)
f_{v90d} = 79.63 N/mm (shear force buckling)
⇒ utilization: U_0 = 0.50, U_{90} = 0.45 ⇒ **U = 0.50 verification successful**

2.3.6. Load combination 6:

with h_{eff} = 5.625 m, $_{max}V_d$ = 11.728 kN ⇒ s_{v0d} = 2.09 N/mm, s_{v90d} = 2.91 N/mm (shear flow)
sheathing 1
k_{mod} = 0.69, $F_{v,Rd}$ = 620 N, f_{v0d} = 2.42 N/mm², f_{v90d} = 9.12 N/mm²
f_{v0d} = 6.02 N/mm (fastener) ⇒ decisive
f_{v0d} = 14.77 N/mm (plate shear strength)
f_{v0d} = 23.16 N/mm (shear force buckling)
f_{v90d} = 9.12 N/mm (fastener) ⇒ decisive
f_{v90d} = 88.88 N/mm (plate shear strength)
f_{v90d} = 79.63 N/mm (shear force buckling)
⇒ utilization: U_0 = 0.35, U_{90} = 0.32 ⇒ **U = 0.35 verification successful**

3. Summary

maximum utilization of all verifications U_{max} = 0.99 ≤ 1 ⇒ **all verifications successful**